

(b) Use Kuhn-Tucker method to solve

$$\text{Maximize } Z = 2x_1 - x_1^2 + x_2$$

Subject to the constraints :

$$2x_1 + 3x_2 \leq 6$$

$$2x_1 + x_2 \leq 4$$

$$x_1, x_2 \geq 0.$$

Reg. No. :

3446 •

Q.P. Code : [23 21 23]

(For the candidates admitted during 2023 onwards)

M.Sc. DEGREE EXAMINATION, NOVEMBER 2025.

Fourth Semester

Part III — Mathematics

OPTIMIZATION TECHNIQUES

Time : Three hours

Maximum : 75 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The main reason integer programming is more difficult than linear programming is
 - (a) The objective function is non linear
 - (b) The feasible region is non-convex
 - (c) Simplex cannot be applied at all
 - (d) The dual does not exist.

2. Which of the following is a real world application of integer programming?
- (a) Airline crew scheduling
 - (b) Faculty location
 - (c) Capital budgeting
 - ☒ (d) All of the above.
3. Dynamic Programming is primarily used for solving problems that involve
- (a) Single-stage decision making
 - (b) Random decision making
 - (c) Linear decision making
 - ☒ (d) Multi-stage decision making.
4. In DP terminology, the variable that defines the systems condition at a stage is called
- (a) Objective variable
 - (b) Decision variable
 - ☒ (c) State variable
 - (d) Slack variable.

5. Which of the following is not considered inventory?
- (a) Raw materials
 - (b) Finished products
 - ☒ (c) Machines
 - (d) Work-in-progress.
6. In the EOQ model, if annual demand increases the EOQ ;
- ☒ (a) Increases proportionately
 - (b) Remains same
 - (c) Decreases proportionately
 - (d) Becomes zero.
7. In queueing theory, the arrival process is typically modeled as :
- (a) Deterministic
 - ☒ (b) Poisson process
 - (c) Exponential distribution
 - (d) Uniform distribution.

8. In a multi-server queue M/M/S, the traffic intensity is

- (a) $\lambda/S\mu$ (b) $S\lambda/\mu$
(c) λ/μ (d) μ/λ

9. Stochastic Programming deals with situations where some or all parameters of the problem are

- (a) Random variable
(b) Constants
(c) Integers
(d) Deterministic.

10. For a convex non linear programming problem the KKT conditions are

- (a) Necessary but not sufficient
(b) Sufficient but not necessary
(c) Both necessary and sufficient
(d) Neither necessary nor sufficient.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b) from each.

11. (a) Discuss the zero-one implicit enumeration algorithm.

Or

- (b) Explain Gomory cutting plane algorithm for solving ILP.

12. (a) Write the key applications of dynamic programming.

Or

- (b) Write the essential characteristics of dynamic programming.

13. (a) The annual demand for an item is Rs. 3,200 units. The cost is Rs. 6. The inventory carrying cost is 25% per annum per unit. The cost if one procurement is Rs. 150. Determine (i) EOQ (ii) Total Amount Cost.

Or

- (b) Discuss costs involved in inventory control also explain total inventory cost.

14. (a) Discuss the elements of a Queuing model.

Or

- (b) In a car wash station cars arrive for service according to Poisson distribution with mean 4 per hour. The average service time of a car is 10 min. Determine the probability that an arriving car has to wait. Also find the average time a car stay in the station.

15. (a) Explain thy Kuhn-Tucker model.

Or

- (b) Write a short note on quadratic programming.

SECTION C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b) from each.

16. (a) Solve the following IPP using Gomary's method :

$$\text{Maximize } Z = x_1 + x_2$$

Subject to the constraints :

$$3x_1 + 2x_2 \leq 5$$

$$x_2 \leq 2$$

$$x_1, x_2 \geq 0 \text{ are integers.}$$

Or

- (b) Use the branch and bound method to solve the following IPP.

$$\text{Maximize } Z = 2x_1 + 2x_2$$

Subject to the constraints :

$$5x_1 + 3x_2 \leq 8$$

$$x_1 + 2x_2 \leq 4$$

$$x_1, x_2 \geq 0 \text{ and are integers.}$$

17. (a) Find the minimum value of

$$z = y_1^2 + y_2^2 + y_3^2$$

$$\text{Subject to } y_1 + y_2 + y_3 \geq 15$$

$$y_1, y_2, y_3 \geq 0.$$

Or

- (b) Solve the following LPP by the method of dynamic programming :

$$\text{Maximize } Z = 2x_1 + 5x_2$$

Subject to :

$$2x_1 + x_2 \leq 430$$

$$2x_2 \leq 460$$

$$x_1, x_2 \geq 0.$$

18. (a) Explain Economic Order Quantity (EOQ) Model in inventory.

Or

- (b) A contractor supplies diesel engines to a truck manufacturer at the rate of 25 per day. The penalty for deals is Rs. 10 per day per engine. The holding cost is Rs. 16 per month. What should be the level of inventory at the beginning of each month.

19. (a) Explain Multiple-Server Queueing model . Also derive the expected number of customers in the queue L_q .

Or

- (b) Patients arrive at a clinic at the rate of 30 patients per hour. The waiting hall cannot accommodate more than 14 patients. It takes 3 min. on the average to examine a patient.

- (i) Find the probability that an arriving patient need not wait.
(ii) What is the expected duration of time a patient spends in the clinic.

20. (a) Solve by Lagrangian multiplier method :

$$\text{Minimize } Z = x_1^2 + x_2^2 + x_3^2$$

Subject to the constraints :

$$4x_1 + x_2^2 + 2x_3 \leq 14$$

$$x_1, x_2 \geq 0.$$

Or

20. (a) Solve : Minimize $Z = -\log x_1 - \log x_2$
subject to the constraints
 $x_1 + x_2 \leq 2$ and
 $x_1 \geq 0, x_2 \geq 0$, by Kuhn Tucker method.

Or

- (b) Solve by Lagrangian multiplier method :
Minimize $Z = 6x_1^2 + 5x_2^2$
Subject to the constraints
 $x_1 + 5x_2 = 3$,
 $x_1, x_2 \geq 0$.
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(For the candidates admitted from 2023 onwards)

M.Sc. DEGREE EXAMINATION, APRIL 2025.

Fourth Semester

Part III — Mathematics

OPTIMIZATION TECHNIQUES

Time : Three hours

Maximum : 75 marks

SECTION A — ($10 \times 1 = 10$ marks)

Answer ALL the questions.

Choose the correct answer :

1. In branch and bound technique method LPP has no _____.
- (a) Feasible point
 - (b) Feasible solution
 - (c) Feasible region
 - (d) None

2. In a mixed integer programming problem
- (a) Only few of the decision variables require integer solutions
 - (b) Different objective functions are mixed together
 - (c) All of the decision variables require integer solutions
 - (d) None of the above
3. Dynamic programming problem
- (a) can be solved only by recursive equation approach
 - (b) cannot be solved using recursive equation approach
 - (c) does not suggest an optimum solution
 - (d) under certainly involves those problems whose conditions at each stage are known with certainty
4. The forward and backward recursions yield the _____.
- (a) Same solution
 - (b) Different solutions
 - (c) Optimum solution
 - (d) None

5. The simplest of the inventory models involves constant-rate demand with instantaneous order replenishment a _____.
- (a) Shortage
 - (b) Setup cost
 - (c) No shortage
 - (d) Purchase cost
6. Inventories in general are built up to
- (a) carry reserve stocks to avoid shortages
 - (b) satisfy demand during period of replenishment
 - (c) keep pace with changing market conditions
 - (d) none of these
7. Multiple servers may be
- (a) in combination of parallel and series
 - (b) in series
 - (c) in parallel
 - (d) all of the above
8. The order in which customers are selected from a queue is called _____.
- (a) source
 - (b) inter arrival time
 - (c) queue
 - (d) queue discipline

9. Which of the following is not correct?

- (a) If the given QPP is in the minimization form, we convert it into that of maximization by appropriate adjustment in $f(x_1, x_2, \dots, x_n)$
- (b) The Fletcher method is an iterative method that uses an active set of strategy
- (c) The Fletcher method uses the classical calculus results
- (d) None of the above

10. Which of the following methods of solving a quadratic programming problem is based on modified simplex method?

- (a) Beale's method
- (b) Wolfe's method
- (c) Fletcher's method
- (d) Frank-Wolfe method

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

Short Answer Questions.

11. (a) Describe Gomory's method of solving an all integer linear programming problem.

Or

- (b) Discuss the advantages of the branch and bound method.

12. (a) Discuss the steps involved in cargo-loading model.

Or

- (b) What are the essential characteristics of dynamic programming problem?

13. (a) Explain the significance of lead time and safety stock in inventory control.

Or

- (b) Discuss the types of cost in inventory control.

14. (a) Derive the formula for P_n and $E(n)$, where, $P=1$ in $\{(M/M/1):(N/FIFO)\}$ queuing model.

Or

- (b) Explain $\{(M/M/1):(N/FCFS)\}$ queuing system and solve it under steady state condition.
15. (a) Write short notes on application of non linear programming problem.
- Or
- (b) Explain the Kuhn-Tucker method.

SECTION C — ($5 \times 8 = 40$ marks)

Answer ALL questions.

Essay Type Questions.

16. (a) Explain zero-one implicit enumeration algorithm with an example.

Or

- (b) Use branch and bound method to solve the following integer programming problem.

$$\text{Maximize } Z = 2x_1 + 3x_2$$

Subject to the constraints

$$5x_1 + 7x_2 \leq 35,$$

$$4x_1 + 9x_2 \leq 36;$$

$x_1, x_2 \geq 0$ and are integers.

17. (a) Write the applications of dynamic programming with Reliability Improvement Problem.

Or

- (b) Find the minimum value of $Z = x_1^2 + 2x_2^2 + 4x_3$

Subject to constraints

$$x_1 + 2x_2 + x_3 \geq 8,$$

$$x_1, x_2, x_3 \geq 0.$$

18. (a) Give any four assumptions of classical EOQ model of inventory control and talk about EOQ with price breaks.

Or

- (b) Discuss the limitations of ABC analysis? Explain how to overcome these limitations by incorporating other inventory control techniques.

19. (a) Write the characteristics of $\{(M/M/C):(N/FIFO)\}$ model.

Or

- (b) The time between arrivals at the game room in the student union is exponential with mean 10 minutes.

(i) What is the arrival rate per hour?

(ii) What is the probability that no students will arrive at the game room during the next 15 minutes?